CORNELL UNIVERSITY ANNOUNCEMENTS

OCTOBER 2, 1964

MEDICAL SCIENCES 1964—1966

GRADUATE SCHOOL OF MEDICAL SCIENCES

CORNELL UNIVERSITY
MEDICAL COLLEGE

GRADUATE SCHOOL OF MEDICAL SCIENCES

1964-1965 and 1965-1966

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GRADUATE SCHOOL OF MEDICAL SCIENCES

PURPOSE AND NATURE OF GRADUATE STUDY

THE GRADUATE School of Medical Sciences of Cornell University offers facilities for advanced study and research for students desiring a comprehensive view of a field of knowledge and training for investigation in that field. Accomplishment is judged more by competence and a growing sense of responsibility for the advancement of knowledge than by fulfillment of routine requirements or by courses and credits. The faculty of the School requires of all candidates for advanced degrees a period of study in residence, advanced competence in some one subject, an adequate introduction to allied subjects, and the passing of language, qualifying, and final examinations, the latter including presentation and defense of a satisfactory thesis.

The Graduate School of Medical Sciences offers work leading to the M.S. and Ph.D. degrees in the basic science fields. In the Sloan-Kettering Division of the Graduate School of Medical Sciences, however, M.S. degrees are awarded only in the field of radiation physics.

The degree of Doctor of Philosophy is granted not only as a result of the fulfillment of certain technical requirements such as residence study or satisfactory completion of graduate courses, but it bespeaks as well the development and possession of a critical and creative ability in science and of a fruitful expression of the imagination. Evidence of the latter is given in the dissertation that the candidate prepares and which constitutes an original research contribution to the field of knowledge chosen for study.

GRADUATE SCHOOL HISTORY

Work leading to an advanced degree was first offered in the Medical College in 1912 as a cooperative arrangement with the Graduate School of Cornell University. Under the plan as originally announced, students registered for an advanced degree in the Medical College, but in all respects they were subject to the rules and regulations prevailing at the University. The departments offering graduate instruction were identified in the first announcement merely as the "scientific departments."

Graduate work has continued to occupy a place in the Medical College since the year it was established, and advanced degrees have been awarded

in anatomy, bacteriology and immunology, biochemistry, pathology, pharmacology, physiology and biophysics, and public health and preventive medicine.

In June, 1950, the trustees of Cornell University approved an arrangement whereby the Sloan-Kettering Institute became a part of the Graduate School division of the Medical College for the purpose of offering instruction leading to graduate degrees in the basic science fields. Although the Cornell University Medical College and the Sloan-Kettering Institute were already closely associated, this arrangement made possible the extension of graduate work into specialized areas. This expansion of the New York City component of the Graduate School prompted the faculty of the University's Graduate School to give consideration to matters of administration, with the result that by action of the trustees in January, 1952, the Graduate School of Medical Sciences was established, which, with the approval of the Graduate School faculty of Cornell University, "shall have full responsibility for advanced and professional degrees granted for study in residence at the New York City campus of Cornell University."

FACILITIES

The Medical College

The five buildings of the College extending along York Avenue from 68th to 70th Streets contain the classrooms, student laboratories, library, and research facilities for undergraduate work. Students in the Graduate School carry on their work on all floors of the College buildings. They are not only eligible to take any of the subjects with the regular medical students, but in most instances certain of these courses are required of the candidate for an advanced degree.

The Sloan-Kettering Division

The Sloan-Kettering Division is in the Sloan-Kettering Institute and the Kettering Laboratory on East 68th Street in New York City, and the Walker Laboratory in Rye, New York. These institutions are devoted to research on cancer and allied conditions. The special facilities and staff of experienced investigators of the Sloan-Kettering Division offer ample opportunities for advanced training in biochemistry, biology, biophysics, cytology, genetics, immunology, microbiology, pathology, pharmacology, physiology, preventive medicine, virology, and related disciplines.

ORGANIZATION OF THE SCHOOL

The Dean

The Dean of the Medical College, who holds the additional title of Associate Dean of the Graduate School of Medical Sciences, is the administrative head. He reports annually to the Graduate School faculty of Cornell University for approval of the activities of the Graduate School of Medical Sciences.

The Faculty

The faculty includes the professors, associate professors, and assistant professors (excepting those in clinical fields) in all departments of the Medical College and of the Sloan-Kettering Division.

The Committee of the School

The Committee of the Graduate School of Medical Sciences is both an administrative and judicial board. The Committee considers matters referred to it by the faculty or by members of the faculty and may on its own initiative make recommendations to the faculty on any matters concerning the interests or policies of the Graduate School of Medical Sciences.

The Associate Dean serves as chairman of this Committee with four members of the Graduate faculty. Two members of the Committee represent the faculty of the Sloan-Kettering Division and the remaining two members are chosen from the faculty in the basic science fields of the Medical College. The faculty members of the Committee are nominated by the Associate Dean and appointed annually by the President of the University.

The Committee serves as an agency for: (1) approval and administration of the admission of students, (2) approval of major and minor subjects, (3) allotment of units of credit toward advanced degrees, (4) selection of members of the faculty to conduct and make recommendations in the fulfillment of the language requirements, and (5) student discipline.

ADMISSION

For admission to the Graduate School of Medical Sciences, an applicant (1) must have a baccalaureate degree or the equivalent from a college or university of recognized standing, (2) must have adequate preparation in the chosen field of instruction, and (3) as judged by his previous record, must show promise of ability to pursue advanced study and research.

A student should not apply for admission until he has conferred with

a faculty member in a major discipline in either the Medical College or the Sloan-Kettering Division and has obtained the faculty member's consent to sponsor his program. The faculty member, in sponsoring the student for major work, is responsible (provided the student is accepted) for planning the program for the student. In consultation with other faculty members who teach in the student's minor fields, the sponsor organizes and acts as chairman of a faculty group, the student's Special Committee.

Scores made in the Graduate Record Examination, although not required, will prove helpful in determining the acceptability of the applicant. Students who plan to take this examination should communicate directly with the Educational Testing Service, Princeton, New Jersey.

For students planning to take up graduate work at the beginning of the academic year in September, the application and all supporting data must be in the Office of the Graduate School at the Medical College not later than May 15.

Proficiency tests to examine his background in any or all of the basic sciences presented as preparation for the fields constituting any candidate's major and minor subjects may be required at the discretion of the candidate's major sponsor. The tests are given a few days before initial registration. Each test will cover material normally presented in undergraduate courses in those sciences. The results of these tests will be used to aid the candidate's Special Committee in planning his course of study. While the results of these tests will not be considered in the usual sense of "passing" or "failing," low marks in one or more of the tests may require a preponderance of elementary courses.

A student is not admitted to the Graduate School until a formal notice of acceptance has been issued by the Associate Dean of the Graduate School of Medical Sciences. If the candidate is accepted with conditions, these will be recorded in the notice of admission.

REGISTRATION

Students taking work in the Graduate School of Medical Sciences must register in the Administration Office of the Medical College at the beginning of the fall and spring terms and the summer research period. It is expected that students who matriculate will continue for the full academic year. Should circumstances require attendance for less than a year, special arrangements may be made for registering for one semester. A graduate student who has completed the residence requirements for his degree and who remains in residence while working on his thesis or while doing other work in contemplation of a degree must register each term in which he is so engaged.

A graduate student who discontinues his work during a term in which he is registered should immediately report this fact to the Associate Dean in order to obtain an official withdrawal or an honorable dismissal.

MAJOR AND MINOR SUBJECTS

The curriculum of a candidate for the degree of M.S. consists of a major and one minor subject; of a candidate for the degree of Ph.D., a major and two minor subjects. Approved subjects are listed below as separate fields of instruction. A candidate is urged to select minor subjects which do not fall in the same general field of instruction as his major.

Graduate students taking courses in the Graduate School of Medical Sciences must register for each course and take the final examination or have the office records marked "incomplete." Courses may be audited with the permission of the department head, but no credit will be given.

SPECIAL COMMITTEES

Special Committees are the means for directing individual candidates in the attainment of that independence implicit in advanced degrees. While a candidate is choosing his major and minor subjects, he selects, with approval of the Associate Dean, eligible members of the faculty to represent each subject and to serve as his Special Committee. The representative of the major subject is Chairman. The Chairman prepares reports for the Associate Dean on grades in formal courses and performance in research and makes requests for qualifying and final examinations. Any faculty member is eligible to serve on these committees, but the Chairman must be of professorial rank. An instructor may serve on a Special Committee as representative for a minor subject.

The members selected indicate their willingness to serve by signing the record of major and minor subjects, which is filed with the Associate Dean.

Members of the Special Committee instruct or supervise the instruction of a candidate, judge whether the student's progress is satisfactory, conduct qualifying and final examinations, and approve the thesis. Although they are the candidate's advisers, it is the responsibility of the candidate himself to become familiar with the various regulations that apply to his case and to satisfy them in the proper way.

There are no regulations of the Graduate faculty on the content of instruction or courses to which the Special Committee must subscribe. The Special Committee may impose any requirements that it deems necessary over and above the general requirements.

RESIDENCE REQUIREMENTS

Study in residence is essential. The faculty requires of each candidate for a Master's degree a minimum of two residence units. Candidates for a Master's degree who receive fellowships must complete all requirements for the degree within two years of initial registration. For the doctorate, a minimum of six residence units is required. One residence

unit represents one academic semester of full-time study or research toward the doctoral thesis.

Although technical competence results from intensive study of a major subject and properly related minor subjects, candidates are urged to avoid overspecialization.

Graduate students who participate in teaching or assist in research work do not qualify for full residence credit although their duties usually will lie in the field of their major interest. In general, a student who gives time to a related service, not to exceed 6 hours a week, is eligible for full credit. If his other duties require 20 hours a week, the earned credit ordinarily will not exceed ¾ of a unit each semester. By earning an additional ½ unit in summer research, he may earn 2 full units in a calendar year. But as a rule, the Committee will not permit anyone to receive credit for more than 2 units in any period of twelve consecutive months. Eligibility to receive residence units and fractions of units is determined by the Committee of the Graduate School of Medical Sciences.

Since the Master's degree is granted *after* the candidate has studied in residence for at least two semesters, no residence unit or fraction is granted in fulfillment of the requirements for this degree for study outside the Graduate School. No commitment may be made for acceptance of previous study in another graduate school in lieu of required residence until after the candidate has entered into study in residence in the Graduate School. Then the residence units, which are evaluated by the Committee on the basis of a transcript of record and other credentials, may not exceed those that would be earned under similar circumstances at Cornell University; and passing courses or acquiring credit hours is not regarded as evidence satisfactory in itself for transfer of credit. Study as a candidate or as a special student in an undergraduate college is not acceptable, even though the courses may be designed for graduate students. A candidate for the degree of Ph.D. must complete two of the last four units in successive terms of study at the Graduate School of Medical Sciences. In instances, however, where a candidate is taking a portion of his work under a cooperative arrangement with departments located on the University campus at Ithaca, an exception may be made to this regulation.

Graduate students in the Graduate School of Medical Sciences may undertake formal studies or may conduct research on the Ithaca campus. By prior arrangement, such a student registers in the Graduate School at Ithaca and works under an adviser resident at Ithaca who may be appointed as an optional member of the student's Special Committee. This same privilege is available to graduate students from the Ithaca campus who find it desirable to conduct studies at the Graduate School of Medical Sciences.

Each candidate for an advanced degree is expected to complete his study in residence with reasonable continuity. A candidate who fails to register during any period of four or more years is dropped from candidacy and may be readmitted only after the Committee of the Graduate

School of Medical Sciences has stipulated the amount of additional residence to be required. No more than ten years may intervene between the time of first registration and the completion of all requirements for a doctorate degree.

LANGUAGE REQUIREMENTS

Students planning graduate study leading to an M.S. or Ph.D. degree must demonstrate proficiency in one language within the first semester following acceptance. This requirement cannot be satisfied by a language test passed in fulfillment of requirements for an advanced degree in another graduate school.

To demonstrate proficiency, the candidate is required to pass a general examination. The examination will consist of passages from the biological sciences designed to test the student's ability to translate a representative piece of prose. The examination will be graded "pass" or "fail" on the basis of whether the student has demonstrated sufficient speed and accuracy to make language a useful instrument for research. The use of a dictionary is allowed. A vocabulary test may be required in addition to the above general examination.

For the M.S. degree a reading knowledge of either French, German, or Russian will fulfill the requirement. Failure to pass the language may require the candidate to complete three units of residence credits for the degree. The student will be expected to demonstrate proficiency before beginning the third residence unit.

A candidate for the degree of Ph.D. must demonstrate reading ability in two foreign languages other than his native language, chosen from the following four: French, German, Russian, English. A candidate may petition to substitute other languages for French, German, or Russian. Foreign students may, with permission of the Committee of the Graduate School, count their native language, except English, as one of the two required foreign languages. Specific reasons must be offered for the proposed substitutions, e.g., that the language is needed in conducting research for the candidate's thesis. Candidates who receive permission to substitute another language for either French, German, or Russian shall be required to take a written examination in that language at a specified time under an examiner appointed by the Associate Dean.

Language requirements must be completed satisfactorily before a student begins work for his last two residence units.

EXAMINATIONS

A final examination is required for the M.S. degree.

A qualifying examination and a final examination are required for the Ph.D. degree.

The qualifying examination serves to determine the ability of the candidate to pursue research work toward the doctoral thesis and must be taken during the first year of residence. The candidate will be examined on various aspects of his major and minor subjects. The major sponsor may select any members of the faculty to assist the Special Committee in this evaluation. The examination will be written or written and oral, and the grades for this examination, together with a copy of the questions used in the written examination, must be sent to the office of the Associate Dean of the Graduate School of Medical Sciences.

The final examination is usually taken in two parts: examination A and examination B. Examination A, which may be oral or oral and written, covers major and minor subjects. It may be taken not earlier than two weeks before completion of the fourth unit of residence and must be taken at least four months before examination B. Examination B is oral and is designed to constitute a defense of the candidate's thesis.

Decision that a candidate has passed or failed his final examination rests solely with the members of the candidate's Special Committee, although all members of the faculty are invited to attend the oral examination.

GRADES

Credit for graduate work is given only when the candidate does well in both his major and minor fields of study. Professors having charge of the work of graduate students are required to report to the Associate Dean of the Graduate School of Medical Sciences at the end of each semester, or at the close of each academic year, grade ratings on all students taking work under their direction. These grade reports are given in the following terms: A (93–100), B (84–92), C (75–83), and F for work unacceptable for credit. Students whose average grade falls below a B may be dropped.

THESES

Research accomplishment presented in the form of a thesis is a principal requirement for both the M.S. and Ph.D. degrees.

Students enrolled for the Master's degree are required to prepare a report on some problem or project undertaken in their major field. In content and form this report must show scholarly attainment.

A candidate for the degree of Master of Science, or Ph.D. must submit an outline and early draft of the thesis or essay to all members of the Special Committee *at least six weeks* before the Final Examination unless this requirement is modified by the Special Committee. At least fifteen days before the Final Examination, the candidates shall provide each member of the Special Committee with a typed copy of the thesis which the Committee members may retain until the time of the examination.

The essay or thesis submitted to the Special Committee at least fifteen days before the Final Examination may be modified as a result of the Final Examination, but at the time of the examination, it must be complete in all respects and editorially acceptable for final approval. Subsequent to the examination the final copies of the thesis, with the signed Thesis Approval form and copies of the endorsed abstract of a doctoral thesis, must be deposited at the Graduate Office on or before the last day for completing requirements and not more than sixty days after the Final Examination.

Doctoral theses must show ability to do critical and independent investigation, must be a contribution to knowledge, and must be presented in a scholarly fashion. They should reflect not only a mastery of a field of research, but the ability to select an important problem for investigation and to deal with it competently. A date for the final examination will be set only after written notice has been given to the Associate Dean by the professor in charge of the candidate's major that the thesis is approved.

The plan in effect in the Graduate School of Cornell University of using the facilities of the University Microfilms, Ann Arbor, Michigan, has been adopted by the faculty of the Medical College. This arrangement provides for publication of the thesis on microfilm and for the publication of an abstract of the dissertation of not more than 600 words in the monthly publication entitled *Dissertation Abstracts*.

The thesis must be typewritten, double-spaced, on durable rag bond 8½ by 11 inches, with a left-hand margin of at least an inch and a quarter. A new black ribbon should be used so as to obtain a clear dense copy for each page, and the ribbon copy (original) must be deposited with the Associate Dean at least 15 days before examination B. One carbon copy, which should be on paper of lighter weight than bond, is also required for deposit in the department where the thesis work was done. Both the original and the one carbon copy of the thesis are submitted unbound.

NON-CANDIDATES AND PROVISIONAL CANDIDATES

Wherever staff and facilities are available, a student who has no announced intention of working toward an advanced degree may be admitted as a non-candidate and register for such formal or informal instruction as he is adequately prepared to undertake. The work of a non-candidate is under the supervision of an adviser selected by the student and approved by the Associate Dean. He is subject to the general regulations of the Graduate faculty. A student who wishes to change from non-candidacy to candidacy must file a new application with the Associate Dean.

A student who is not considered to be completely qualified for candidacy may be admitted as a provisional candidate. In such instance he may reapply for admission to candidacy after a period of study not exceeding two semesters. If he is admitted into candidacy, he is not allowed to transfer more than one semester of study in fulfillment of residence requirements.

A candidate for the Master's degree who wishes to change to candidacy for the Doctor's degree must file a new application with the Associate Dean.

EXPENSES

A fee of $1800 an academic year must be paid by all students registered in the Graduate School of Medical Sciences. This is an inclusive fee with $1514 of the amount apportioned for tuition and the remainder for all accessory items; namely, matriculation, student hospitalization insurance, laboratory charges, graduation fee, microfilming of the doctoral thesis, publishing the abstract in the monthly periodical, *Dissertation Abstracts,* mailing the thesis and abstract to and from the microfilm publishers, binding two copies of the thesis, and the tuition fee. The fee is due at the beginning of the academic year, or in two equal parts of $900 at the beginning of the fall and spring semesters.

The head of the department may recommend that a certain graduate student is needed in the teaching program, and, if approved by the Associate Dean, a salary will be given to the student in an amount equal to his tuition, but exclusive of other fees. The tuition charge as such, however, is not waived in any instance.

Graduate students who have completed the minimum residence requirements (six units) for the Ph.D. degree and have paid the tuition fees for that degree may complete their theses in residence and take the final examinations by registering as candidates for degree only. No additional tuition payment will be required, but a registration fee of $286 per academic year will be charged to cover hospitalization insurance, etc.

Tuition or other fees may be changed by the Board of Trustees at any time without previous notice.

STUDENT HEALTH SERVICE

Complete ambulatory medical care is provided for all students matriculated in the Graduate School of Medical Sciences through the Personnel Health Service of the Medical Center. Students matriculating for the first time in the Graduate School are required to have a physical examination by a member of the Health Service staff. In addition each student must report for a chest X-ray examination, tuberculin test, and such im-

munizations as may be considered necessary at periodic intervals. No charge is made for medical care through the Health Service or for any X-rays, laboratory tests, or procedures which may be needed. Each student is required to carry Associated Hospital Service (Blue Cross) hospitalization insurance unless some similar hospitalization insurance is currently in effect through a previous policy. The cost of this insurance for an unmarried student is included in the "Expense" fee. Wives and dependents of students may be covered by the hospitalization insurance policy for a small additional fee. Office hours are held Monday through Friday from 12:30 to 1:30 p.m. by the Student Health staff. All cases of illness must be reported to the Health Service. Students may have in attendance physicians of their own choice, but a reasonable amount of cooperation between such physicians and the College Health Service is expected. Wives and families of students are not eligible for care through the Personnel Health Service but will be referred to appropriate members of the hospital staff for medical care.

SUMMARY OF REGULATIONS FOR GRADUATE STUDENTS

A student contemplating admission to graduate work leading to the M.S. or Ph.D. degree must first obtain the approval of his program from a member of the faculty. If encouraged by the faculty member to proceed, the student may file his application.

When registered for one of these degrees, the candidate should observe carefully the following requirements:

For the Master's Degree

He must—

1. Complete a minimum of two units of work in residence, including a major and one minor course of study.
2. Demonstrate proficiency in one foreign language.
3. Pass a final examination covering his general field of study.
4. Present a thesis approved by the professor representing his major field of study and the Committee of the Graduate School of Medical Sciences.
5. Submit two typewritten copies of the thesis, one for filing in the Medical College Library and the other for the department representing his major field of study.

For the Ph.D. Degree

He must—

1. Complete six units of training in residence, of which two units of the last four must be taken in successive terms at the Medical College or the Sloan-Kettering Division.

2. Demonstrate proficiency in two languages approved by the Committee of the Graduate School of Medical Sciences.

3. Achieve a high level of scholarly capacity (grade of B or better) and demonstrate the ability and technique necessary for carrying on original work.

4. Complete the following examinations: (1) a qualifying examination during the first year of residence, and (2) the final examinations.

5. Present a thesis in the major field of study, which must represent a contribution to the subject investigated.

6. Prepare an abstract of the approved thesis for publication in *Dissertation Abstracts.*

7. Submit two unbound typewritten copies of the thesis at least 15 days before examination B, one for filing in the Medical College Library and the other for the department representing the major field of study.

RESEARCH SOCIETIES

Sigma Xi, a national honorary society devoted to the encouragement of scientific research, was founded at Cornell University at Ithaca in 1886. An active branch of the Cornell Chapter is maintained at the Medical College. Graduate students are eligible for election to membership in Sigma Xi on the basis of proved ability to carry on original research and on nomination by active members of the Cornell Chapter. Graduate students elected to the society prior to enrolling at Cornell are invited to become active members of the local chapter.

The Cornell University Medical Research Society holds several evening meetings each year. This informal society offers faculty members of all divisions of the Center an opportunity to present papers dealing with original research. Graduate students are invited to attend the meetings and to submit papers for possible presentation.

FIELDS OF INSTRUCTION

THE SEVERAL fields of instruction of the Graduate School of Medical Sciences are described in the pages that follow. The title of each field is an approved major or minor subject for candidates for advanced degrees.

INSTRUCTION AT THE MEDICAL COLLEGE

Anatomy

Professors Roy C. Swan, Joseph C. Hinsey (Neuroanatomy)
Associate Professors Wilbur D. Hagamen, John MacLeod, Leonard L. Ross
Assistant Professors Saul Bader, Dorothea Bennett, Dana C. Brooks, Thomas H. Meikle, Jr., Benjamin D. Stinson
Instructors Donald A. Fischman, Michael D. Gershon, Richard G. Skalko

Facilities are available for graduate study in various areas of the broad subject of anatomy: in histology, cytology, electron microscopy, neuroanatomy, experimental neurology, male fertility, embryology, and genetics. Students desiring to pursue graduate work in anatomy must have had adequate preliminary training at college level in physics, chemistry, and biology. The specific course requirements for either a major or a minor in anatomy will be determined for each candidate after consultation with the authorized representatives of the other departments involved.

ELECTIVE COURSES AVAILABLE TO GRADUATE STUDENTS

1. *Advanced Genetics.* Seminar on special topics in genetics; topic for each semester to be chosen according to special interest and requirements of students. Dr. Bennett.
2. *Fine Structure of Cells.* Lectures and demonstrations on specimen preparation, use of the electron microscope, and darkroom procedures. Lectures and seminars on the fine structure of cells. Each student will conduct an independent research project. Dr. Ross.
3. *Human Male Fertility.* Dr. MacLeod.

Biochemistry

Professor Vincent du Vigneaud
Associate Professors Roy W. Bonsnes, Aaron S. Posner, Julian R. Rachele
Assistant Professors Esther M. Breslow, William D. Cash, W. Y. Chan, Helena Gilder, Julius Golubow, S. Steven Hotta, Theodore A. Mahowald
Instructors John J. Ferraro, Barbara M. Ferrier, Edward T. Schubert

Opportunity is offered for advanced work and research in various phases of biochemistry. Adequate chemical and physical equipment and library facilities are provided for the investigation of a considerable variety of problems in the chemistry of the animal and human organism in health and disease.

Graduate students expecting to pursue investigations in biochemistry should have adequate training in inorganic, organic, analytical, and physical chemistry.

Students electing biochemistry as a minor subject are expected to complete the regular medical course in biochemistry, or its equivalent, and to participate in the biochemistry seminars as a minimum requirement.

Microbiology

Professors William F. Scherer, John Y. Sugg

Assistant Professors Irving Abrahams, Sidney E. Grossberg, William M. O'Leary, Bob S. Roberson, Dieter H. Sussdorf

Instructor Robert W. Dickerman

Candidates for the Ph.D. degree and postdoctoral fellows can select an area of research interest and activity from such microbiological fields as general and medical bacteriology, microbial chemistry and physiology, microbial genetics, immunology, mycology, and virology.

Prospective students should complete in undergraduate school a minimum of one year—or its equivalent—in general chemistry, organic chemistry, general physics, mathematics including college algebra, botany or zoology (preferably both), and one semester or its equivalent of analytical or quantitative chemistry. General microbiology or bacteriology and calculus are strongly recommended. Students who have not completed the above requirements may be admitted to graduate study on the condition that deficiencies be removed soon after admission.

Courses in graduate work are determined by the student's Special Committee made up of faculty representing his major and minor subjects. Included for Ph.D. candidates in microbiology are the following courses: medical microbiology, microbial chemistry and physiology, advanced immunology, advanced virology, microbial genetics, microbiology seminar, biochemistry, and biostatistics.

The nature and number of other courses depend on the student's minor subjects, his research activities, his individual interests, and the advice of his Special Committee. Such courses at this institution or at near-by universities are available in anatomy, biophysics, cell biology, histology, mycology, parasitology, pathology, pharmacology, physiology, and radiobiology.

Pathology

Professors John G. Kidd, Robert C. Mellors

Associate Professors A. Whitley Branwood, Aaron Kellner, George E. Murphy, Goetz W. Richter, John F. Seybolt, Jean E. Todd

Assistant Professors Peter M. Burkholder, William D. Johnson, Richard P. Karoll, Richard M. Torack

Instructors Carl G. Becker, Jack W. C. Hagstrom, Andrew H. Littell, Jr., C. Richard Minick, William W. Schlaepfer, Leslie H. Sobin

The department offers wide opportunity for the experimental study of disease. Adequate facilities for the care of animals are available. There is a departmental library where some of the current journals and reference books are kept on file. There is a carefully selected collection of mounted museum specimens, in addition to an active file of preserved gross material for study. The histological collection is likewise rich in material. Autopsies for the entire hospital are performed by the members of the department and offer an opportunity for the study of fresh pathological tissues.

No regular course of study is offered by the department for graduate students, but applicants in this field are given abundant opportunity for special work under the direct supervision of members of the department. Such work may include the investigation of some problem and may be credited toward the applicant's graduate degree.

Pharmacology

Professor WALTER F. RIKER, JR.
Associate Professors WALTER MODELL, JAY ROBERTS, FRANK G. STANDAERT
Assistant Professors AMIR ASKARI, ALBERT S. KUPERMAN
Instructors WILLIAM T. BEAVER, ALAN VAN POZNAK

Facilities are available for advanced work and research in the chemical, pharmacodynamic, and clinical aspects of pharmacology. Special opportunities are afforded for work in general pharmacology, neuropharmacology, cardiovascular pharmacology, biochemical pharmacology, and drug evaluation in man. The department is well equipped with specialized apparatus for electrophysiological and biochemical techniques.

In graduate training, emphasis is placed on a sound basic training in general pharmacology. By means of individual instruction, the candidate is later afforded an exposure to several specialized aspects of pharmacology. The latter part of the graduate curriculum is devoted to research in an area of the candidate's choice.

An adequate preliminary training in organic chemistry, physical chemistry, biochemistry, and physiology is prerequisite for graduate work in pharmacology. A training in statistics is strongly recommended.

BIOSTATISTICS. See page 24.

Physiology and Biophysics

Professor ROBERT F. PITTS
Associate Professors GERHARD H. GIEBISCH, ROGER L. GREIF
Assistant Professors D. ROBERT AXELROD, COLIN FELL, HAROLD G. HEMPLING, RICHARD H. KESSLER, SHERMAN KUPFER, ERICH E. WINDHAGER

Graduate and research training is provided for students who wish to prepare themselves for teaching and research in the physiological aspects of biological science, with special emphasis on the physical and chemical approach; those who desire to prepare themselves more adequately for clinical practice and research by advanced training in some phase of physiology; and those who are entering a career in human biology.

Public Health

Professors WALSH MCDERMOTT, LEONA BAUMGARTNER, JOHN R. HELLER, WILLIAM T. INGRAM, EDWIN D. KILBOURNE
Associate Professor JAMES R. MCCARROLL
Assistant Professors SAMUEL R. BERENBERG, AARON D. CHAVES, FLOYD M. FELDMANN, AUGUST H. GROESCHEL, RENE I. JAHIEL, ANN P. KENT, ROBERT M. MCCUNE, PHILIP OLLSTEIN, JEROME L. SCHULMAN, MELVIN S. SCHWARTZ

In this department of the Medical College, a graduate degree (Ph.D.) may be obtained in certain of the medical sciences as they relate to public health. Microbiology is a field of special interest of the department; advanced training and instruction are available in parasitology, bacteriology, and virology.

The Department of Public Health does not offer formal graduate courses in public health, and the University does not grant a Master's degree or a doctorate in public health.

BIOSTATISTICS. See below.

INTERDEPARTMENTAL COURSES

Biostatistics

Sponsored jointly by the Departments of Public Health and Pharmacology. In weekly meetings throughout the school year "least squares" theory, hypotheses testing with the conventional "t" test and chi-square procedures, analysis of variance, and probit analysis are considered. The course is designed to meet the needs of graduate students in the medical sciences in general, including those who wish to use epidemiologic technics in the conduct of research.

Cell Biology

Given throughout the academic year by staff members of several departments. Recent advances in the understanding of cell structure and function are presented by means of lectures and student seminars. The topics discussed during any semester depend, in part, on the research interests of the staff. They include cell excitation, bacterial cell metabolism, fine structure, permeability, enzyme action, cellular interaction.

The course is open to all graduate students. Registration is arranged through the Graduate School Office.

Genetics Seminar

An advanced seminar in gentics is offered each term by the faculties of the Medical College Division and the Sloan-Kettering Division. The seminar consists of one two-hour session per week for four academic terms, and is repeated every second year. Eight or more university-credit hours in genetics, or attendance at the lectures pertaining to genetics given in the Department of Anatomy and the instructor's permission are required for admission. Two terms are required for a minor in genetics, and all four terms are required for a major in genetics.

INSTRUCTION AT THE SLOAN-KETTERING DIVISION

Frank L. Horsfall, Jr., *Director*
Liebe F. Cavalieri, *Associate Director*

GENERAL PLAN . . . The predoctoral program of the University is designed to meet the individual needs of the student. There is no particular set of lecture

or laboratory courses for any given area. The instructional program of one candidate does not necessarily bear any relationship to the program of another candidate registered for the same subject. It is up to the student to decide first on a general area of interest for his major subject and then to discuss the program with one or several professors who may serve as sponsors.

Listed below are some of the specialized lecture and seminar courses offered in the Division.

Graduate Seminar

The weekly graduate seminar is offered each year and is attended by all graduate students of the Division. The subjects covered vary from year to year, but in general they deal with problems of modern biology. Two or three topics are selected for discussion each year, and an attempt is made to rotate the subjects on a three-year cycle. Topics are usually chosen from the following: nucleic acid and protein chemistry and biochemistry; chromosome structure and function; special topics in bacterial genetics; regulation; radiobiology; mammalian and bacterial viruses. The discussion is carried principally by graduate students under the guidance of faculty members whose area of specialization coincides with the topic. From time to time outstanding authorities in the field are invited as guest speakers.

Special Topics Course

The Special Topics course covers subjects similar to those of the Graduate Seminar and consists of lectures given by faculty members or guest lecturers, or both. The subject matter varies from year to year. A student is expected to take this course for two years and to audit it during the remaining years, as he will be responsible for the material in Final Examination A.

Predoctoral-Postdoctoral Seminars

An opportunity for exchange of ideas between predoctoral students and postdoctoral fellows of the Sloan-Kettering Institute is provided by these discussions. An informal protocol is followed with a coordinating general theme. The development of critical judgments, rather than the acquisition of facts, is stressed. The seminar is held weekly.

Biochemistry

Professors Aaron Bendich, Oscar Bodansky, George B. Brown, Liebe F. Cavalieri, C. Chester Stock

Associate Professors M. Earl Balis, Ralph K. Barclay, Jack J. Fox, Mary L. Petermann, Morton K. Schwartz, Martin Sonenberg, Helen Q. Woodard

Assistant Professors Ellen Borenfreund, John F. Codington, Paul J. Fodor, Saul Green, Dietrich Hoffmann, Samuel S. Koide, Jerome S. Nisselbaum, Josephine S. Salser, Vladimir P. Skipski

Instructors Mary G. Hamilton, Willi Kreis, Samuel J. Levin, Barbara H. Rosenberg

Supervision and guidance is offered in the fields of enzymology, immuno-

chemistry, bio-organic chemistry, molecular biology, and metabolism of proteins and nucleic acids.

A graduate course in biochemistry is given over a two-year period during the third trimester of each academic year; 28 one and one-half hour lectures will be given each trimester at a rate of two per week. The course will include consideration at an advanced level of the following subjects, with particular attention to contributions of recent research: chemistry and metabolism of proteins, nucleic acids, carbohydrates, fats and steroids; chemical genetics; energy metabolism; classification, purification, mechanism of action and kinetics of enzymes.

Undergraduate requirements for a major in biochemistry include courses in inorganic chemistry, qualitative chemistry, quantitative chemistry, physical chemistry, physics (mechanics, electricity and magnetism, and sound, heat, light), biochemistry, and mathematics (through calculus). If any of these requirements have not been fulfilled at the undergraduate level, they must be taken at the onset of graduate study.

Students electing biochemistry as a minor subject are expected to complete the regular medical course in biochemistry, or its equivalent, as a minimum requirement.

Biology

Professors Frank L. Horsfall, Jr. (Microbiology), Frederick S. Philips (Pharmacology), George W. Woolley

Associate Professors Charlotte Friend (Microbiology), Leonard D. Hamilton, Dorris J. Hutchison (Microbiology), William L. Money, Alice E. Moore, H. Christine Reilly (Microbiology)

Assistant Professors Etienne de Harven, Wilbur F. Noyes III, Lloyd J. Old, Herbert S. Schwartz (Pharmacology), Francis M. Sirotnak (Microbiology), Morris N. Teller

Instructors Alberta M. Albrecht, June L. Biedler, James G. Cappuccino, Louis Kaplan

Students are directed particularly toward the factors which initiate, control, and modify growth. Supervision and guidance is offered in cytology, genetics, virology, immunology, microbiology, endocrinology, and pharmacology.

An advanced seminar in genetics is offered each term by the faculties of the Medical College Division and the Sloan-Kettering Division as outlined on page 24.

Undergraduate requirements for a major in biology include courses in organic chemistry, inorganic chemistry, qualitative chemistry, quantitative chemistry, physical chemistry, physics (mechanics, electricity and magnetism, and sound, heat, light), biochemistry, mathematics (through calculus), anatomy, general biology or general zoology or general botany, general microbiology, physiology, cytology, and genetics. If any of these requirements have not been fulfilled at the undergraduate level, they must be taken at the onset of graduate study.

Prerequisite graduate courses will be determined for each individual on the basis of his particular area of interest.

Biophysics

Professor John S. Laughlin
Assistant Professors Edward R. Epp, Harold Moroson, Ira Pullman
Instructors Karin R. Corey, Peter J. Kenny, Louis Zeitz

Graduate work is offered leading to the degrees of Master of Science in radiation physics and Doctor of Philosophy in biophysics.

The following courses are offered: (1) Radiological Physics: lecture and problems. A series of hourly lectures and assigned problems in applied mathematics, fundamentals of radiation physics, X-ray and radium treatment planning, diagnostic X-ray principles, radiation protection, and uses of radioactive isotopes. (2) Radiation Biophysics: a full-year course covering the fundamentals of radiation physics, radiation chemistry, and radiation biology. (3) Advanced Biophysics: laboratory courses in each of the topics of radiation biophysics. (4) Biophysics Colloquia: reports on research in progress by faculty and outside lecturers: required for majors in biophysics.

The course of study leading to the degree of Master of Science in radiation physics trains physicists in the various aspects of production, measurement, and application of radiations. X-ray and electron machines are available with energies ranging from 5 Kev to 25 Mev. Experience is also provided in the handling and use of many different radioisotopes. The magnitude and variety of facilities and unique radiation projects at the Sloan-Kettering Institute and the Memorial Hospital are particularly pertinent for training in this area. An important feature is the co-existence of fundamental research and practical and clinical applications in the same Center.

Some of the research projects in biophysics which are pertinent to the Ph.D. program include: studies of the metabolism of various isotope-labeled compounds in man; metabolism of biologically important compounds in tissue cultures of human tumor cells, in bacteria, and in viruses; the mechanism of radiation action on bacteria, phage, yeast, and small animals, including metabolic studies with human and other tumors influenced by radiation under different environmental conditions; trace element analysis of tissue sections by means of fluorescent X-ray spectrometers; electron spin resonance spectroscopy of free radicals in carcinogenic and irradiated compounds; the measurement of radiation by calorimetric, radiation-chemical ionization, crystal and solid-state detectors; study of the early radiation-induced processes in cells using high-intensity pulsed irradiation techniques.

Undergraduate prerequisites include courses in general physics, electricity and magnetism, mechanics, mathematics (through calculus), and thermodynamics, and acceptable laboratory experience in these fields. If any of these requirements have not been fulfilled at the undergraduate level, they must be taken at the onset of graduate study.

Pathology

Professors Gilbert Dalldorf, Frank W. Foote, Jr.
Associate Professors Jørgen E. Fogh, Leopold G. Koss, Stephen S. Sternberg
Assistant Professors John W. Berg, Charles P. Miles
Instructors Robert V. P. Hutter, Myron R. Melamed

Special facilities are available for investigation in quantitative cytology and

cellular pathology by newer optical methods, cytophysical methods including radioautography, electron microscopy, ultraviolet and fluorescent microscopy. A regular part of the functions of this department include examinations of the pathologic effects of potential cancer chemotherapeutic agents in laboratory animals.

Study in this department is limited to persons having a medical degree and two years' experience in general pathology.

Preventive Medicine

Associate Professors Leo Wade, Ernest L. Wynder
Assistant Professor Genevieve M. Bader
Instructor Elaine G. Diacumakos

The department offers opportunities for research in epidemiology of cancer, and biological testing and chemical analyses of environmental agents. Special studies in these fields can be arranged with the appropriate members of the department.

Prerequisites are a degree in medicine or advanced training and experience in the field.

REGISTER OF STUDENTS

DOCTORS OF PHILOSOPHY

Felice Brigitte Aull, B.A. 1960, Barnard College; Ph.D. 1964, Cornell University. Major: Physiology. New York, N.Y.

Sulamita Balagura, M.D. 1959, Universidad del Valle; Ph.D. 1963, Cornell University. Major: Physiology. Cali, Colombia, S.A.

Vincent Joseph Cairoli, B.S. 1953, Fordham University College of Pharmacy; Ph.D. 1964, Cornell University. Major: Pharmacology. Fairview, N.J.

René Abba Frenkel, M.S. 1956, University of Chile; Ph.D. 1964, Cornell University. Major: Biochemistry New York, N.Y.

Elias Greene, B.S. 1953, Brooklyn College; Ph.D. 1964, Cornell University. Major: Biology. Rockville Center, N.Y.

Thomas Anthony Krenitsky, B.S. 1959, University of Scranton; Ph.D. 1963, Cornell University. Major: Biology. Throop, Pa.

Eva W. Leckband, B.A., 1953, McMasters University; M.S. 1957, University of Michigan; Ph.D. 1963, Cornell University. Major: Biology. New York, N.Y.

Michiko Okamoto, B.S. 1954, Tokyo University College of Pharmacy; M.S. 1957, Purdue University; Ph.D. 1964, Cornell University. Major: Pharmacology. Tokyo, Japan

Howard Kenneth Sandoval, B.S. 1953, The College of the City of New York; A.M. 1956, Columbia University; Ph.D. 1964, Cornell University. Major: Microbiology. Astoria, New York

James Howe Sherman, B.S. 1957, University of Michigan; Ph.D. 1963, Cornell University. Major: Biology. Ann Arbor, Michigan

Lewis G. Tilney, A.B. 1960, Harvard University; Ph.D. 1964, Cornell University. Major: Anatomy. Far Hills, New Jersey

MASTERS OF SCIENCE

Barrie King, B.S. 1953, University of Western Australia; M.S. 1963, Cornell University. Major: Radiological Physics. South Guilford, West Australia

Hing Har Lo, B.S. 1961, Adelphi College; M.S. 1964, Cornell University. Major: Radiological Physics Hong Kong, B.C.C.

CANDIDATES FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Lorraine S. Abrash, A.B. 1955, Cornell University. Major: Biochemistry. West Englewood, N.J.

Roberta M. Bruck, B.A. 1957, Douglass College; M.A. 1962, Columbia University. Major: Anatomy. Highland Park, N.J.

Loretta Chiuh-Yeou Cheong, B.S. 1948, University of the Philippines; M.S. 1951, University of Michigan. Major: Biochemistry. Manila, P.I.

Gary Citrin, B.S. 1963, Brooklyn College of Pharmacy. Major: Pharmacology. Brooklyn, N.Y.

Anna B. Drakontides, B.A. 1955, Hunter College; M.A. 1960, Hunter College. Major: Anatomy. New York, N.Y.

Ernest Joseph Feleppa, Jr., A.B., 1961, Cornell University. Major: Biophysics. Pelham, N.Y.

Roland A. Finston, A.B.-B.S. 1957, University of Chicago; M.S. 1959, Vanderbilt University. Major: Biophysics. Chicago, Ill.

Anastasia Gregoriades, B.A. 1962; M.A. 1964, Hunter College. Major: Biology. New York, N.Y.

Hanspaul Hagenmaier, Diplomchemiker, 1961 Universitaet Tuebingen. Major: Biochemistry. Geislingen/St., Germany

Judith A. Hartmaier, B.S. 1963, University of Delaware. Major: Biochemistry. Oxford, Pa.

Barbara Ann Knutson, B.A. 1960, Hunter College. Major: Physiology. New York, N.Y.

Frank E. Lilly, B.S. 1951, West Virginia University College of Pharmacy. Major: Pharmacology. New York, N.Y.

Paul Milvy, A.B. 1953; M.S. 1962, Cornell University. Major: Biophysics. New York, N.Y.

Jo Anne Munigle, B.A. 1957, Connecticut College. Major: Anatomy. West Hartford, Conn.

Arthur Myles, B.A. 1960, Middlebury College; M.A. 1962, Wesleyan University. Major: Biochemistry. Yonkers, N.Y.

Margaret R. Payne, B.S. 1964, Medical College of Virginia College of Pharmacy. Major: Biochemistry. Richmond, Va.

Arthur Raines, B.S. 1957, Fordham University College of Pharmacy; M.S. 1960, Columbia University College of Pharmacy. Major: Pharmacology. Jackson Heights, N.Y.

Sarah Schilling, A.B. 1963, Cornell University. Major: Anatomy. Murray Hill, N.J.

Edith R. Schwartz, A.B. 1952, Barnard College; M.A. 1955, Columbia University. Major: Biochemistry. Great Neck, N.Y.

Gloria G. Secunda, B.A. 1963, Wellesley College. Major: Anatomy. New York, N.Y.

Irene A. Skipski, A.B. 1955, Temple University. Major: Biochemistry. New York, N.Y.

David Soifer, B.S. 1961, Columbia University. Major: Anatomy. New York, N.Y.

Chull S. Song, A.B. 1957, Birmingham-Southern College; M.D. 1961, Columbia University. Major: Biochemistry. New York, N.Y.

Lloyd M. Stempel, B.S. 1956, The College of the City of New York. Major: Biochemistry. Brooklyn, N.Y.

Elliott H. Stonehill, B.S. 1950, The College of the City of New York; M.A. 1956, Brooklyn College. Major: Biochemistry. Mount Vernon, N.Y.

John D. Termine, B.S. 1960, St. John's University; M.S. 1963, University of Maryland. Major: Biochemistry. — Brooklyn, N.Y.
Arnoldo K. Ventura, B.Sc. 1961, University College of the West Indies. Major: Microbiology. — Jamaica, B.W.I.
William A. Volpert, B.S. 1962, The College of the City of New York. Major: Pharmacology. — New Rochelle, N.Y.
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